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Kabuto

(10) **Patent No.: US 9,270,922 B2**
(45) **Date of Patent: *Feb. 23, 2016**

(54) **TRANSMISSION SYSTEM AND RELAY DEVICE**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **14/264,295**

(22) Filed: **Apr. 29, 2014**

(65) **Prior Publication Data**

US 2014/0232939 A1 Aug. 21, 2014

Related U.S. Application Data

(63) Continuation of application No. 13/316,757, filed on Dec. 12, 2011, now Pat. No. 8,732,785.

(30) **Foreign Application Priority Data**

Mar. 9, 2011 (JP) 2011-050971

(51) **Int. Cl.**
H04N 5/38 (2006.01)
H04N 5/63 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H04N 5/63*** (2013.01); ***G09G 5/006*** (2013.01); ***H04N 5/38*** (2013.01); ***H04N 21/43635*** (2013.01); *G09G 2330/02* (2013.01);
(Continued)

(58) **Field of Classification Search**
USPC 348/723; 725/141, 153
See application file for complete search history.

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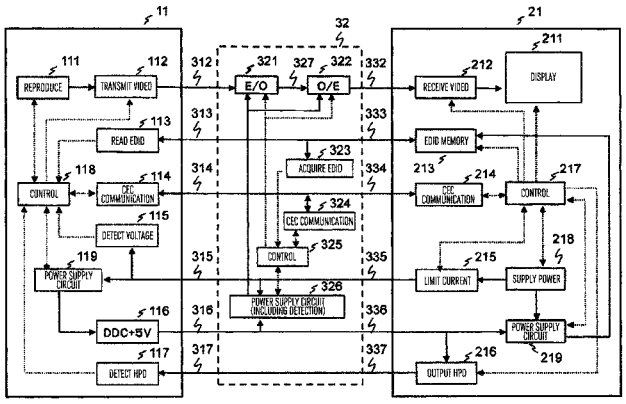
Primary Examiner — Nnenna Ekpo
(74) *Attorney, Agent, or Firm* — Baker Botts L.L.P.

(57) **ABSTRACT**

Provided is a system for supplying a power from a sink device to a source device. Not only the source device but also a cable or a repeater device to be connected thereto has compatibility in power supply. A physical address obtained from information of an EDID memory forms a base of CEC message exchange, but a physical address of the cable or repeater device is overlapped with the source device or unknown. The cable or a repeater device uses changes the type of a message while using the same physical address as the source device or use such a message having the physical address information of the source device is described in a parameter of the message using the unknown physical address. The message having a supply or reception current for each device described therein is exchanged with the sink device or the source device to adjust current reception.

4 Claims, 16 Drawing Sheets



(51) **Int. Cl.**
H04N 21/4363 (2011.01)
G09G 5/00 (2006.01)

(52) **U.S. Cl.**
CPC *G09G2370/04* (2013.01); *G09G 2370/06* (2013.01); *G09G 2370/12* (2013.01); *G09G 2370/18* (2013.01)

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Office Action, dated Nov. 11, 2015, which issued during the prosecution of Chinese Patent Application No. 201110412939.5, which corresponds to the present application.

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FIG. 1

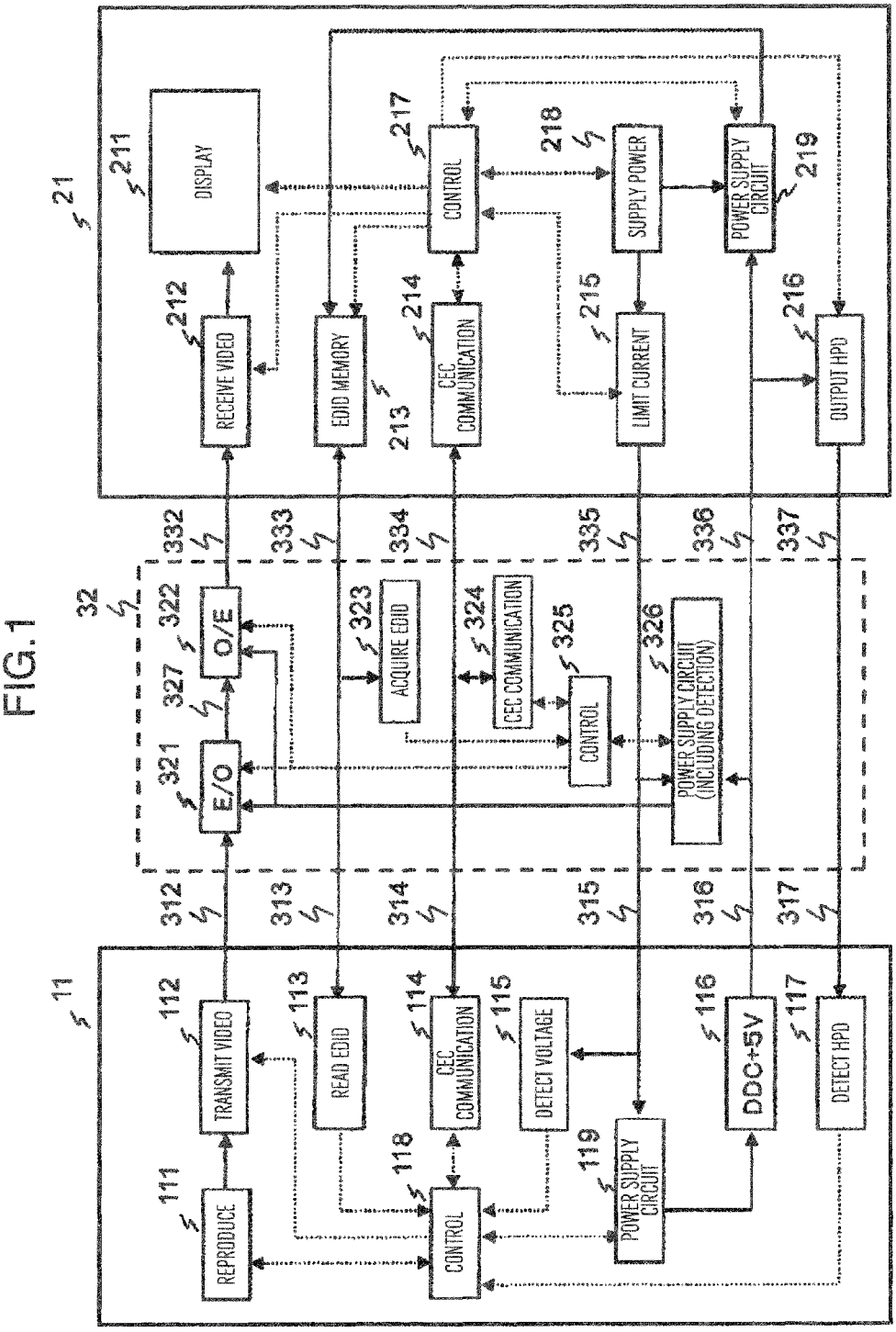

11
21
32
DISPLAY
211
RECEIVE VIDEO
212
EDID MEMORY
213
CEC COMMUNICATION
214
LIMIT CURRENT
215
OUTPUT HPD
216
CONTROL
217
SUPPLY POWER
218
POWER SUPPLY CIRCUIT
219
O/E
322
E/O
321
ACQUIRE EDID
323
CEC COMMUNICATION
324
CONTROL
325
POWER SUPPLY CIRCUIT (INCLUDING DETECTION)
326
327
REPRODUCE
111
TRANSMIT VIDEO
112
READ EDID
113
CEC COMMUNICATION
114
DETECT VOLTAGE
115
DDC+5V
116
DETECT HPD
117
CONTROL
118
POWER SUPPLY CIRCUIT
119
312
313
314
315
316
317
332
333
334
335
336
337

FIG.2

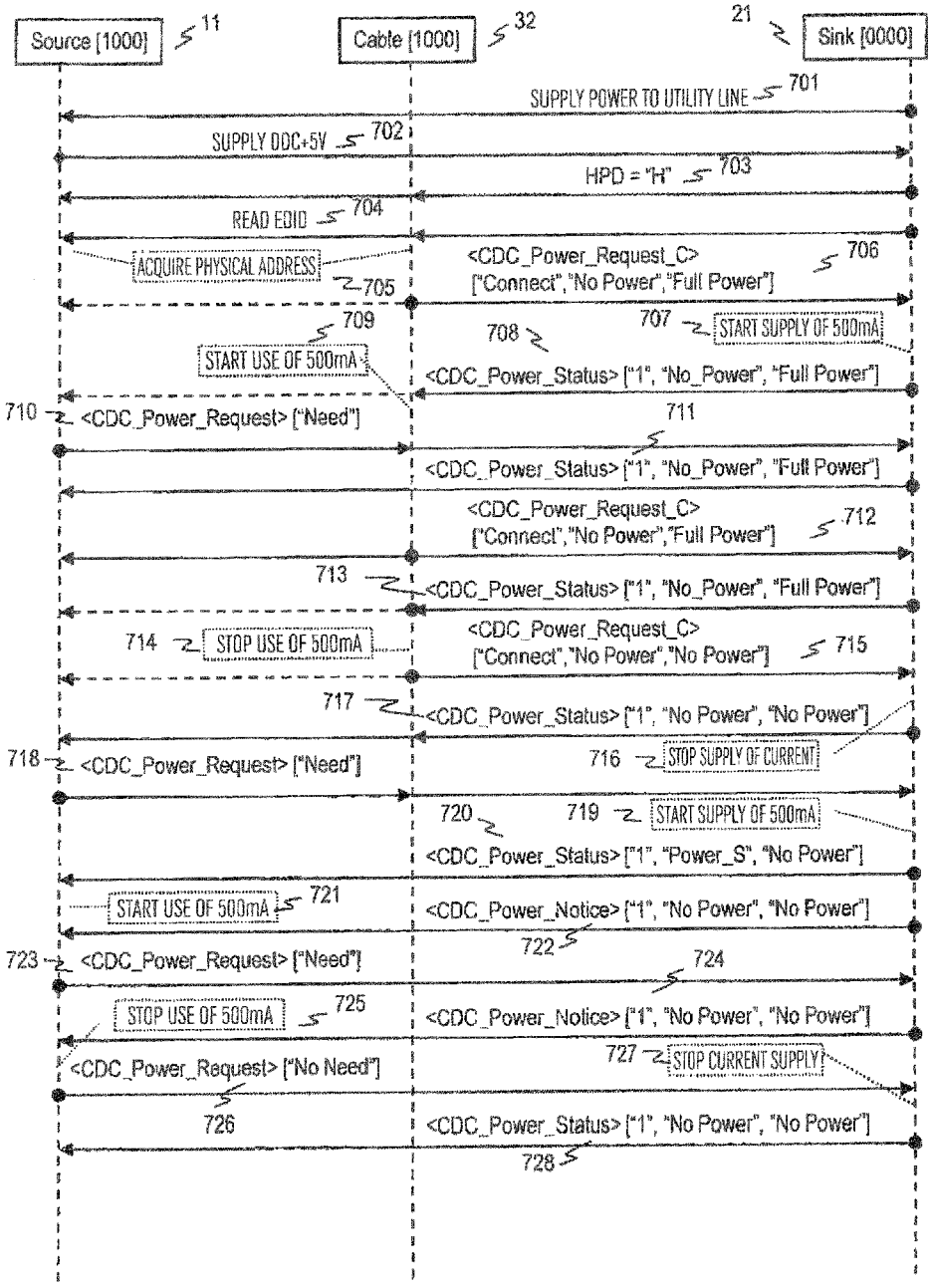
FIG.3

CDC Opcode	Parameters	Parameter description	Response
<CDC_Power_Request>	[Power_Source]	Requesting current.	<CDC_Power_Status> <CDC_Power_Request_C>
<CDC_Power_Status>	[Power_Sink]	Supplying current.	-
<CDC_Power_Notice>	[Power_Sink]	Will change to this current.	<CDC_Power_Request> <CDC_Power_Request_C>
<CDC_Power_Request_C>	[Power_Cable]	Requesting current and supplying current.	<CDC_Power_Status>
<CDC_Power_Notice_C>	[Power_Cable]	Will change to this current for a Source.	<CDC_Power_Request>

FIG.4

Name	Range Description		Length	Purpose
[Power_Source]	"No need"	0	1 bit	A Source does not need power from a Sink.
	"Need"	1		A Source requires power from a Sink or a Cable.
	Reserved		7 bits	Set to "0000000".
[Power_Sink]	[Input Port Number] [P_Source] [P_Cable]		1 byte	
[Input Port Numver]	Sink's Input Port Number		4 bits	Specify a Sink's input port number. Same as the last number except 0 in the connected Source Physical Address.
[P_Source]	"No Power"	0	2 bits	A Source is allowed to consume no power form a Sink nor a Cable.
	"Half Power"	1		A Sink supply half power to each a Source and a Cable.
	"Power_S"	2		A Source is allowed to consume power from a Sink.. .
	"Power_C"	3		A Source is allowed to consume power from a Cable (not a Sink)..
[P_Cable]	"No Power"	0	2 bits	A Cable is allowed to consume no power.
	"Half Power"	1		A Sink supply half power to each a Source and a Cable.
	"Full Power"	2		A Cable is allowed to consume power from a Sink..
	Reserved	3		
[Power_Cable]	[Wire] [P_Source] [P_Cable]		1 byte	
[Wire]	"Connect"	0	1 bit	Utility line is connected between the connecters.
	"No Connect"	1		Utility line is not connected between the connecters.
[P_Source]			2 bits	
[P_Cable]			2 bits	
Reserved			3 bits	Set to "000".

FIG.5


Source [1000]
11
Cable [1000]
32
21
Sink [0000]
SUPPLY POWER TO UTILITY LINE
701
SUPPLY DDC+5V
702
HPD = "H"
703
READ EDID
704
ACQUIRE PHYSICAL ADDRESS
705
<CDC_Power_Request_C>
["Connect","No Power","Full Power"]
706
START SUPPLY OF 500mA
707
708
START USE OF 500mA
709
<CDC_Power_Status> ["1", "No_Power", "Full Power"]
710
<CDC_Power_Request> ["Need"]
711
<CDC_Power_Status> ["1", "No_Power", "Full Power"]
<CDC_Power_Request_C>
["Connect","No Power","Full Power"]
712
713
<CDC_Power_Status> ["1", "No_Power", "Full Power"]
714
STOP USE OF 500mA
<CDC_Power_Request_C>
["Connect","No Power","No Power"]
715
717
<CDC_Power_Status> ["1", "No Power", "No Power"]
718
<CDC_Power_Request> ["Need"]
716
STOP SUPPLY OF CURRENT
720
719
START SUPPLY OF 500mA
<CDC_Power_Status> ["1", "Power_S", "No Power"]
START USE OF 500mA
721
<CDC_Power_Notice> ["1", "No Power", "No Power"]
722
723
<CDC_Power_Request> ["Need"]
724
STOP USE OF 500mA
725
<CDC_Power_Notice> ["1", "No Power", "No Power"]
727
STOP CURRENT SUPPLY
<CDC_Power_Request> ["No Need"]
726
<CDC_Power_Status> ["1", "No Power", "No Power"]
728

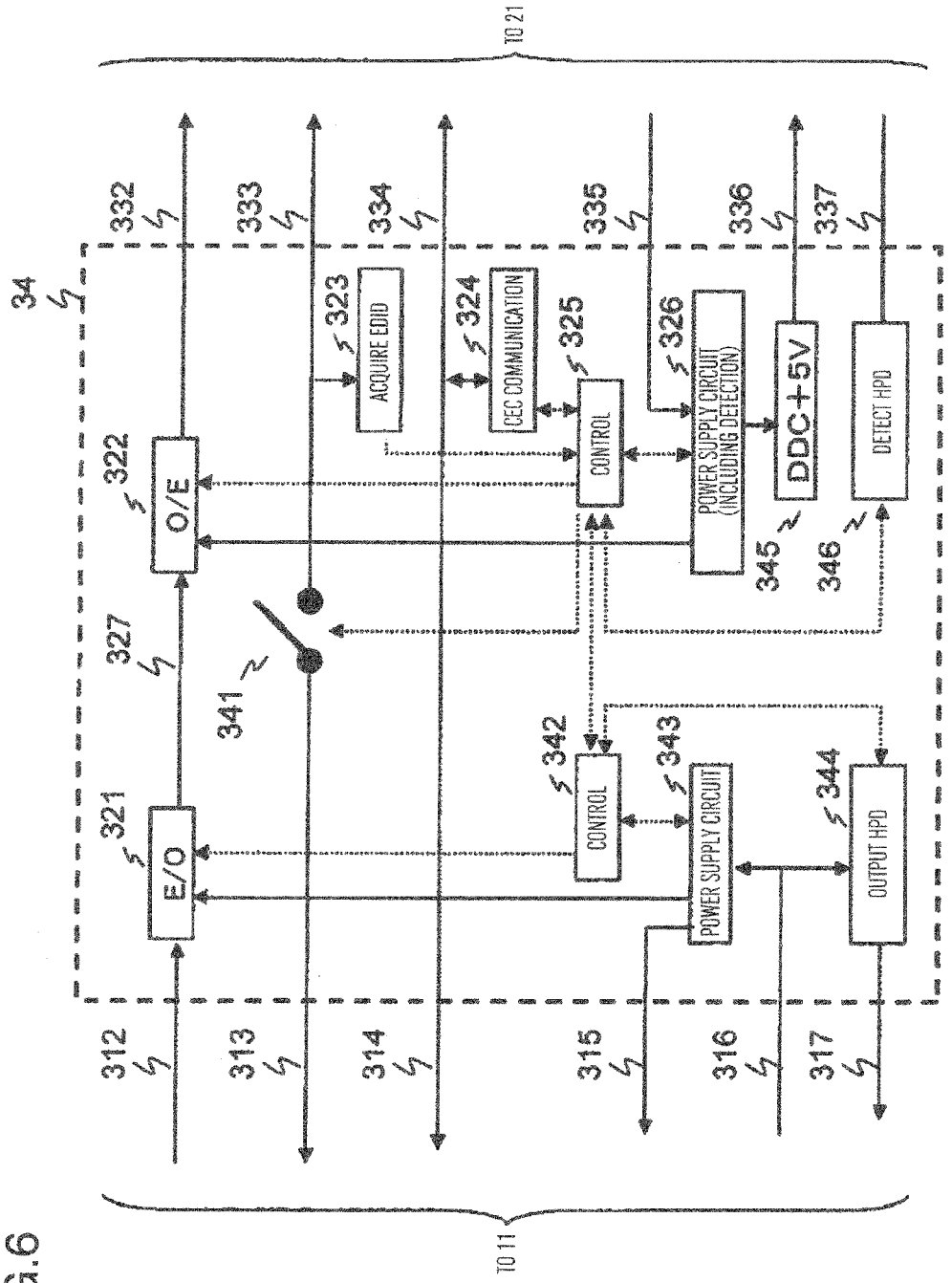

TO 21
34
332
333
334
335
336
337
323
ACQUIRE EDID
324
CEC COMMUNICATION
325
326
POWER SUPPLY CIRCUIT (INCLUDING DETECTION)
DDC+5V
DETECT HPD
322
O/E
CONTROL
345
346
327
341
342
343
344
321
E/O
CONTROL
POWER SUPPLY CIRCUIT
OUTPUT HPD
312
313
314
315
316
317
TO 11

FIG.6

FIG.7

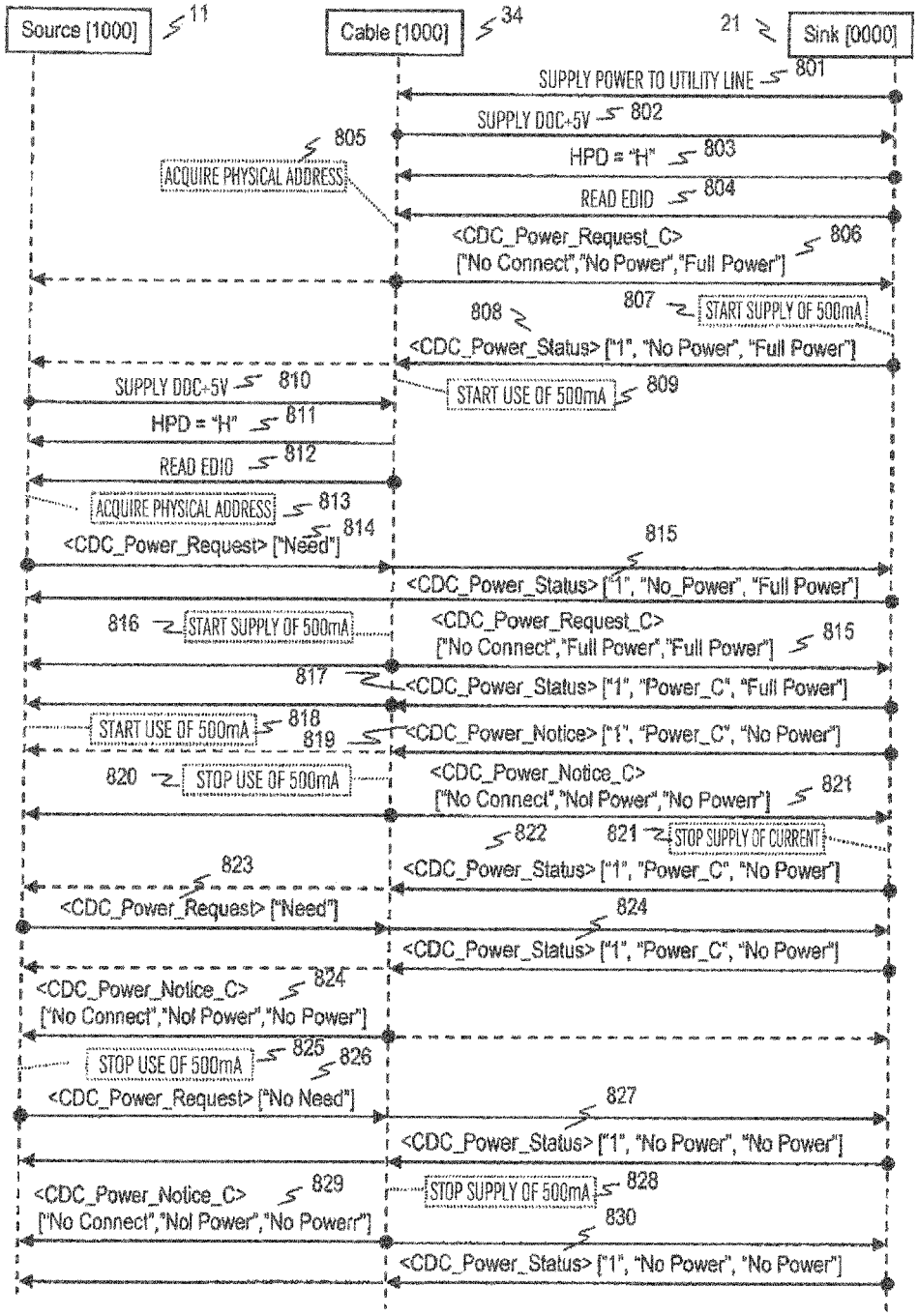

Source [1000]
11
Cable [1000]
34
21
Sink [0000]
SUPPLY POWER TO UTILITY LINE
801
SUPPLY DDC+5V
802
HPD = "H"
803
READ EDID
804
ACQUIRE PHYSICAL ADDRESS
805
<CDC_Power_Request_C>
["No Connect","No Power","Full Power"]
806
START SUPPLY OF 500mA
807
808
<CDC_Power_Status> ["1", "No Power", "Full Power"]
START USE OF 500mA
809
SUPPLY DDC+5V
810
HPD = "H"
811
READ EDID
812
ACQUIRE PHYSICAL ADDRESS
813
<CDC_Power_Request> ["Need"]
814
815
<CDC_Power_Status> ["1", "No_Power", "Full Power"]
816
START SUPPLY OF 500mA
<CDC_Power_Request_C>
["No Connect","Full Power","Full Power"]
815
817
<CDC_Power_Status> ["1", "Power_C", "Full Power"]
START USE OF 500mA
818
819
<CDC_Power_Notice> ["1", "Power_C", "No Power"]
820
STOP USE OF 500mA
<CDC_Power_Notice_C>
["No Connect","Not Power","No Power"]
821
822
821
STOP SUPPLY OF CURRENT
823
<CDC_Power_Status> ["1", "Power_C", "No Power"]
<CDC_Power_Request> ["Need"]
824
<CDC_Power_Status> ["1", "Power_C", "No Power"]
<CDC_Power_Notice_C>
["No Connect","Not Power","No Power"]
824
STOP USE OF 500mA
825
826
<CDC_Power_Request> ["No Need"]
827
<CDC_Power_Status> ["1", "No Power", "No Power"]
<CDC_Power_Notice_C>
["No Connect","Not Power","No Power"]
829
STOP SUPPLY OF 500mA
828
830
<CDC_Power_Status> ["1", "No Power", "No Power"]

FIG.8

Name		Range Description		Length	Purpose
[Power_Source]		[Sink_Current] [Source_Current] [Check_sum]		2 byte	
	[Sink_Current]	"0mA"	0	3 bits	Maximum current that Sink provides.
		"25mA"	1		
		"150mA"	2		
		"275mA"	3		
		"400mA"	4		
		"525mA"	5		
		Reserved	6-7		
	[Source_Current]	"0mA"	0	3 bits	Maximum current that Source is allowable to consume. Note: "5mA" is standby mode. At this case, a Source is allowed to consume 5mA except providing DDC+5V and to connect Utility line and DDC+5V line to read Sink's EDID At other setting, such as larger than 5mA, a Source shall take care to provide 55 mA even if the power on Utility line is provided to DDC+5V line.
		"5mA"	1		
		"125mA"	2		
		"250mA"	3		
		"375mA"	4		
		"500mA"	5		
		Reserved	6-7		
	[Check_sum]	Check sum		2 bits	Sum this message including header, opcode and parameters except starting bit.

FIG.9

Name	Range Description		Length	Purpose
[Power_Sink]	[Input Port Number] [Sink_Current] [Source_Current] [Cable_Current] [Check_sum]		2 bytes	
[Input Port Numver]	Sink's Input Port Number		4 bits	Specify a Sink's input port number. Same as the last number except 0 in the connected Source Physical Address.
Reserved			1 bit	Set to "0".
[Sink_Current]			3 bits	Maximum current that a Sink provides.
[Source_Current]			3 bits	Maximum current that a Source is allowable to consume.
[Cable_Current]	"0mA"	0	3 bits	Maximum current that Source is allowable to consume. Note: When "5mA" is setting as a standby mode, a Cable is allowed to consume under 5mA for a cable itself and connect Utility line and DDC+5V line which connects a Sink under the following cases, 1) No power from a Sink is provided to a Source. 2) A Source is also standby mode "5ma" and a Cable consume no power from a DDC+5V line from source. At other setting, such as larger than 5mA, a Cable shall take care to provide 55 mA even if the power on Utility line is provided to DDC+5V line.
	"5mA"	1		
	"125mA"	2		
	"250mA"	3		
	"375mA"	4		
	"500mA"	5		
	Reserved	6-7		
[Check_sum]			2 bits	

FIG.10

Name	Range Description		Length	Purpose
[Power_Cable]	[Wire] [Power2] [Sink_Current] [Source_Current] [Cable_Current] [Check_sum]		2 bytes	
[Wire]	"Connect"	0	1 bit	Utility line is connected between the connecters.
	"No Connect"	1		Utility line is not connected between the connecters.
[Power2]	"None"	0	1 bit	A Source is allowed to consume no additional power except a Sink.
	"Independent"	1		A Source is allowed to consume additional power other than a Sink.
[Sink_Current]			3 bits	Maximum current that a Sink provides.
[Source_Current]			3 bits	Maximum current that a Source is allowable to consume.
[Cable_Current]			3 bits	Maximum current that a Cable is allowable to consume.
Reserved			3 bits	Set to "000".
[Check_sum]			2 bits	

FIG.11

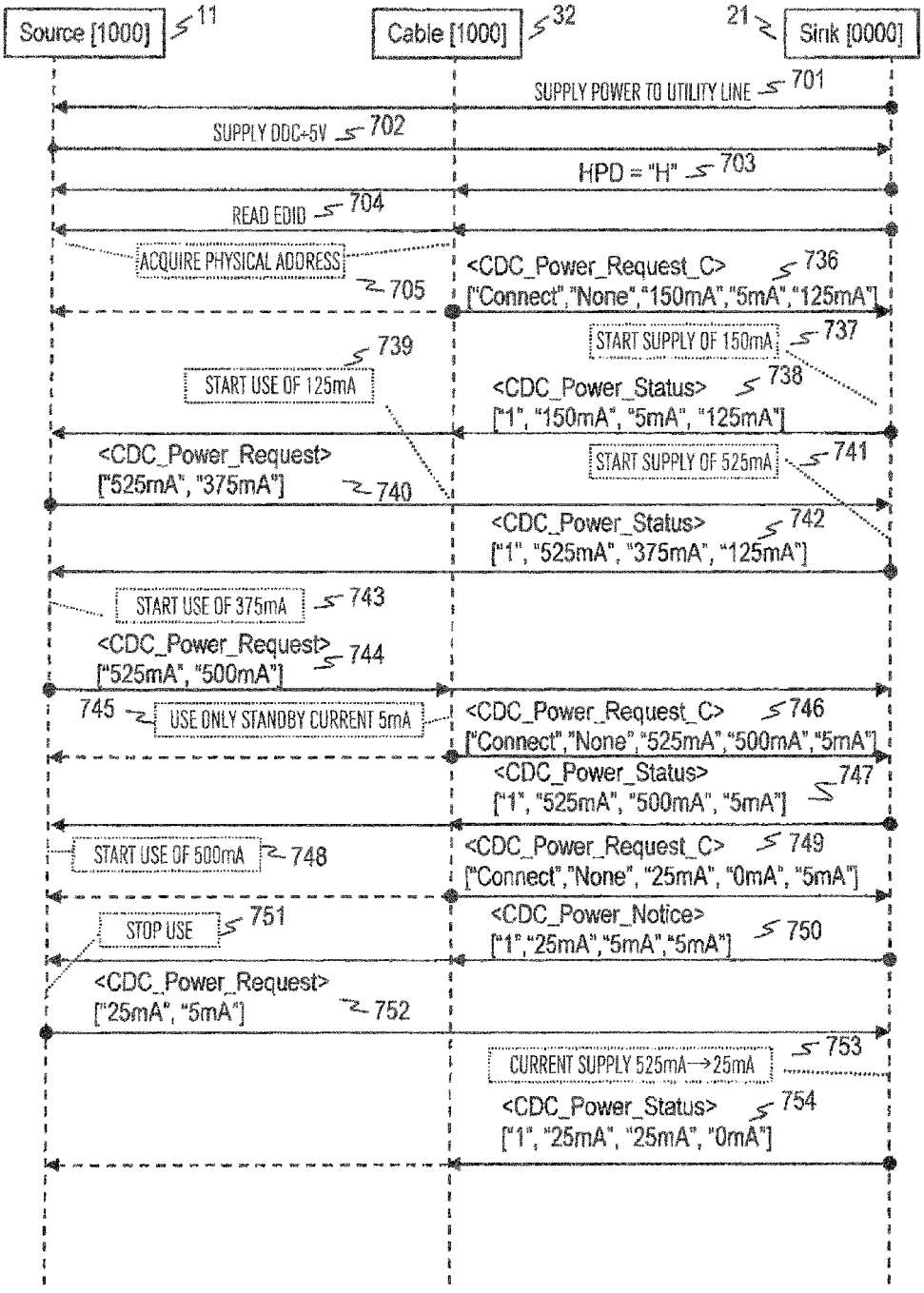

Source [1000]
11
Cable [1000]
32
21
Sink [0000]
SUPPLY POWER TO UTILITY LINE
701
SUPPLY DDC+5V
702
HPD = "H"
703
READ EDID
704
ACQUIRE PHYSICAL ADDRESS
705
<CDC_Power_Request_C>
["Connect","None","150mA","5mA","125mA"]
736
START SUPPLY OF 150mA
737
START USE OF 125mA
739
<CDC_Power_Status>
["1", "150mA", "5mA", "125mA"]
738
<CDC_Power_Request>
["525mA", "375mA"]
740
START SUPPLY OF 525mA
741
<CDC_Power_Status>
["1", "525mA", "375mA", "125mA"]
742
START USE OF 375mA
743
<CDC_Power_Request>
["525mA", "500mA"]
744
745
USE ONLY STANDBY CURRENT 5mA
<CDC_Power_Request_C>
["Connect","None","525mA","500mA","5mA"]
746
<CDC_Power_Status>
["1", "525mA", "500mA", "5mA"]
747
START USE OF 500mA
748
<CDC_Power_Request_C>
["Connect","None", "25mA", "0mA", "5mA"]
749
STOP USE
751
<CDC_Power_Notice>
["1","25mA","5mA","5mA"]
750
<CDC_Power_Request>
["25mA", "5mA"]
752
CURRENT SUPPLY 525mA→25mA
753
<CDC_Power_Status>
["1", "25mA", "25mA", "0mA"]
754

FIG.12

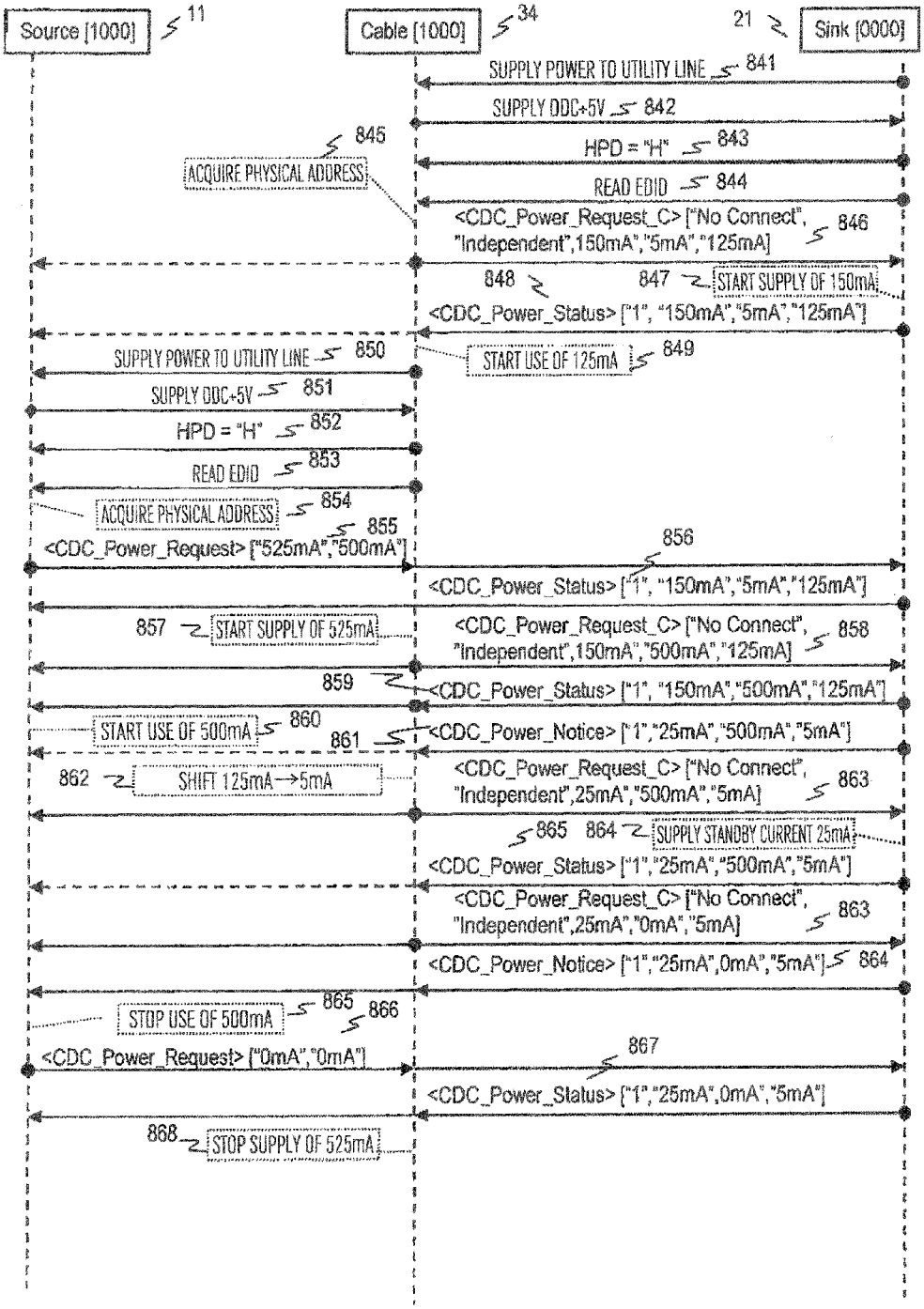

Source [1000]
11
Cable [1000]
34
21
Sink [0000]
SUPPLY POWER TO UTILITY LINE
841
SUPPLY 0DC+5V
842
HPD = "H"
843
READ EDID
844
ACQUIRE PHYSICAL ADDRESS
845
<CDC_Power_Request_C> ["No Connect", "Independent",150mA","5mA","125mA]
846
START SUPPLY OF 150mA
847
848
<CDC_Power_Status> ["1", "150mA","5mA","125mA"]
START USE OF 125mA
849
SUPPLY POWER TO UTILITY LINE
850
SUPPLY 0DC+5V
851
HPD = "H"
852
READ EDID
853
ACQUIRE PHYSICAL ADDRESS
854
<CDC_Power_Request> ["525mA","500mA"]
855
856
<CDC_Power_Status> ["1", "150mA","5mA","125mA"]
START SUPPLY OF 525mA
857
<CDC_Power_Request_C> ["No Connect", "Independent",150mA","500mA","125mA]
858
<CDC_Power_Status> ["1", "150mA","500mA","125mA"]
859
START USE OF 500mA
860
<CDC_Power_Notice> ["1","25mA","500mA","5mA"]
861
SHIFT 125mA→5mA
862
<CDC_Power_Request_C> ["No Connect", "Independent",25mA","500mA","5mA]
863
SUPPLY STANDBY CURRENT 25mA
865
864
<CDC_Power_Status> ["1","25mA","500mA","5mA"]
<CDC_Power_Request_C> ["No Connect", "Independent",25mA","0mA","5mA]
863
<CDC_Power_Notice> ["1","25mA",0mA","5mA"]
864
STOP USE OF 500mA
865
866
<CDC_Power_Request> ["0mA","0mA"]
867
<CDC_Power_Status> ["1","25mA",0mA","5mA"]
STOP SUPPLY OF 525mA
868

FIG.13

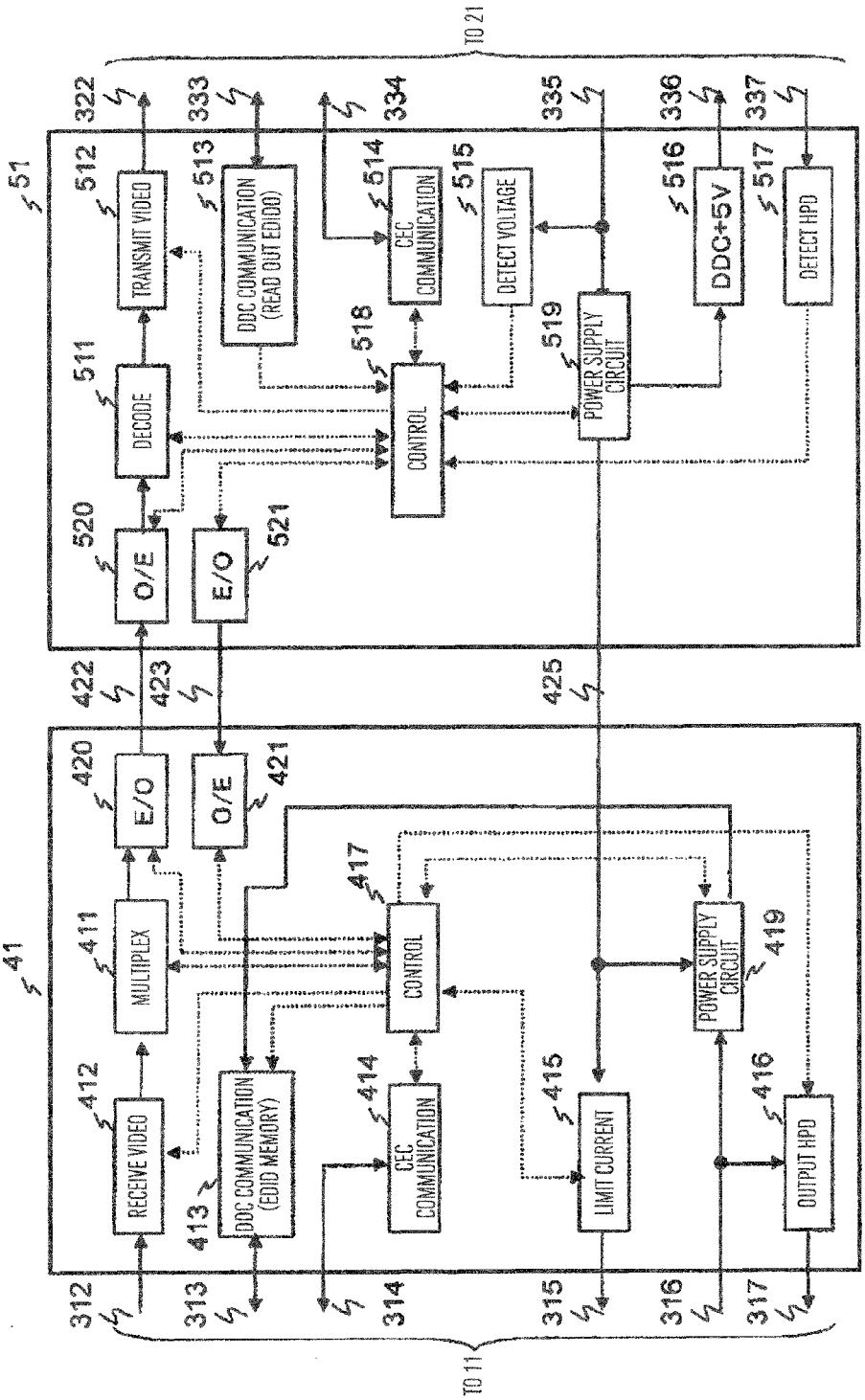

TO 21
TO 11
41
51
RECEIVE VIDEO
MULTIPLEX
E/O
O/E
DDC COMMUNICATION (EDID MEMORY)
CEC COMMUNICATION
CONTROL
LIMIT CURRENT
POWER SUPPLY CIRCUIT
OUTPUT HPD
TRANSMIT VIDEO
DECODE
O/E
E/O
DDC COMMUNICATION (READ OUT EDIDD)
CEC COMMUNICATION
CONTROL
DETECT VOLTAGE
POWER SUPPLY CIRCUIT
DDC+5V
DETECT HPD
312
313
314
315
316
317
322
333
334
335
336
337
412
411
420
421
413
414
417
415
419
416
512
513
514
515
511
518
519
516
517
520
521
422
423
425

FIG.14

Byte # \ Bit	7	6	5	4	3	2	1	0
0	Vender-specific tag code (=3)			Length (=9)				
1-3	24-bit IEEE Registration Identifier (0x00C03)							
4	A				B			
5	C				D			
6,7	.....							
8	0	0	0	Power_present	0	0	0	0
9	Connecting position A Sink takes "00" A device read this value, increment by 1 and get as own value.		Power Type 00; No power 01; Original power 10; Relay power 11; Reserved		Current 0000; No power supply 0001; 25mA (Standby power) 0010; 150mA 0011; 275mA 0100; 400mA 0101; 525mA 0110; Depend on Sink 0111-1111; Reserved			

FIG.15

Name		Range Description		Length	Purpose
[Power_Cable]		[Physical Address] [Connecting position] [Wire] [Power2] [Sink_Current] [Source_Current] [Cable_Current] [Check_sum]		2 bytes	
	[Physical Address]	Source Physical Address		2 bytes	Source Physical address which a cable connects.
	[Connecting position]	Connecting position		2 bits	A Sink takes "00". Increment the value that it reads from EDID.
	[Wire]	"Connect"	0	1 bit	Utility line is connected between the connecters.
		"No Connect"	1		Utility line is not connected between the connecters.
	[Power2]	"None"	0	1 bit	A Source is allowed to consume no additional power except a Sink.
		"Independent"	1		A Source is allowed to consume additional power other than a Sink.
	[Sink_Current]			3 bits	Maximum current that a Sink provides.
	[Source_Current]			3 bits	Maximum current that a Source is allowable to consume.
	[Cable_Current]			3 bits	Maximum current that a Connecting position 1 is allowable to consume.
	[Cable_Current]			3 bits	Maximum current that a Connecting position 2 is allowable to consume.
	[Cable_Current]			3 bits	Maximum current that a Connecting position 3 is allowable to consume.
	Reserved			3 bits	Set to "000".
	[Check_sum]			2 bits	

FIG.16

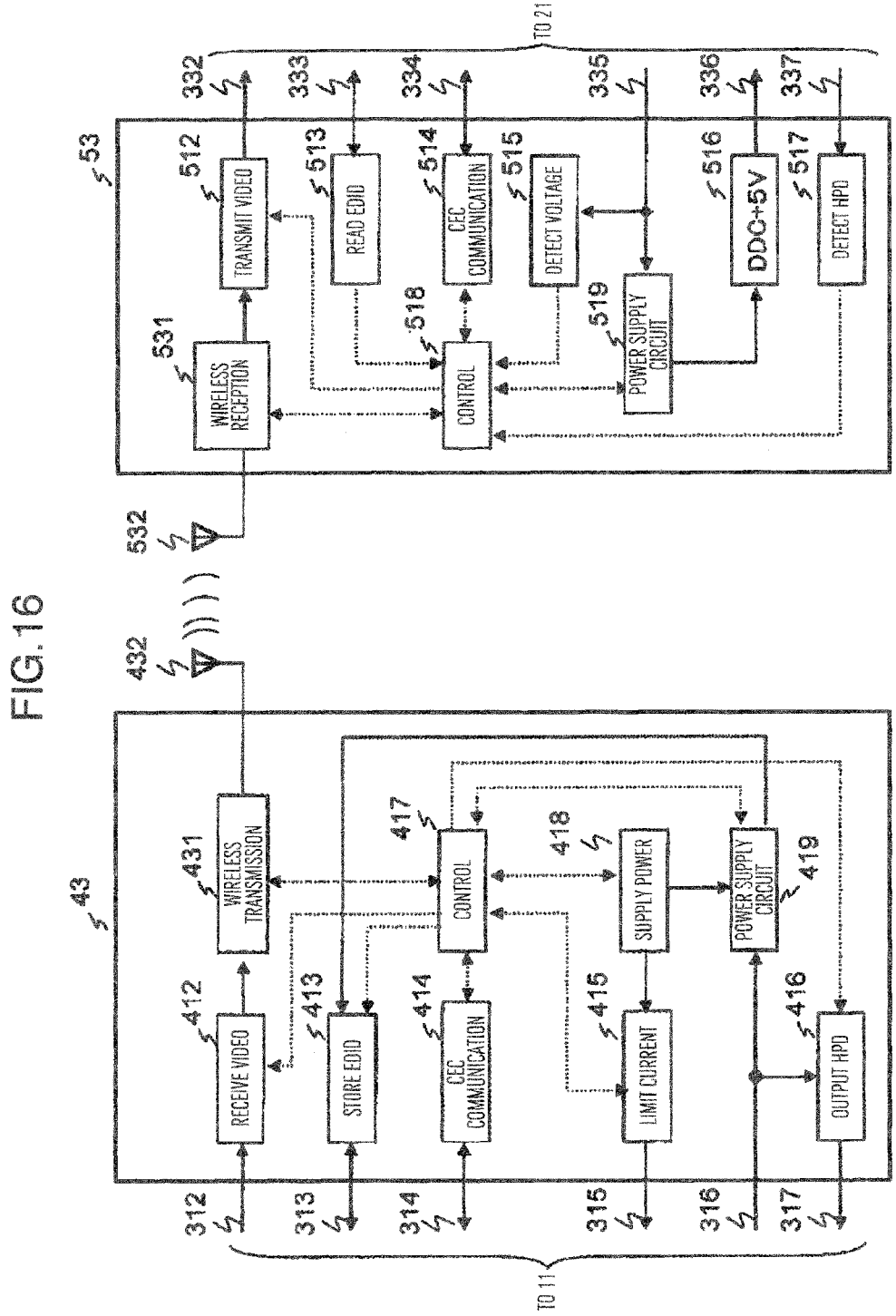

TO 21
53
332
333
334
335
336
337
512
513
514
515
516
517
TRANSMIT VIDEO
READ EDID
CEC COMMUNICATION
DETECT VOLTAGE
DDC+5V
DETECT HPD
531
WIRELESS RECEPTION
518
CONTROL
519
POWER SUPPLY CIRCUIT
532
432
43
431
WIRELESS TRANSMISSION
417
CONTROL
418
SUPPLY POWER
419
POWER SUPPLY CIRCUIT
412
413
414
415
416
RECEIVE VIDEO
STORE EDID
CEC COMMUNICATION
LIMIT CURRENT
OUTPUT HPD
312
313
314
315
316
317
TO 11

FIG.17

Name	Range Description		Length	Purpose
[Power_Source]	"No need"	0	1 bit	A Source does not need power from a Sink.
	"Need"	1		A Source requires power from a Sink or a Cable.
	Reserved		7 bits	Set to "0000000".
[Power_Sink]	[Input Port Number] [Supply_Power]		1 byte	
[Input Port Numver]	Sink's Input Port Number		4 bits	Specify a Sink's input port number. Same as the last number except 0 in the connected Source Physical Address.
[Supply_Power]	"No Power"	00	2 bits	A Sink supplies no Power.
	"Power for Source"	01		A Source is allowed to consume power form a Sink.
	"Power for Cable"	10		A Cable is allowed to consume power. from a Sink.
	"Both"	11		A Source and Cable is allowed to consume half power each, from a Sink.
Reserved			2 bits	
[Power_Cable]	[Connecting position] [Wire] [C_Power]		1 byte	
[Connecting position]	Connecting position		2 bits	A Sink takes "00" and a Repeater increments the value that it reads from EDID.
[Wire]	"Connect"	0	1 bit	Utility line is connected between the connecters.
	"No Connect"	1		Utility line is not connected between the connecters.
[C_Power]	"None"	000	3 bits	A Cable does not consume or supply power on Utility line..
	"Consume Full"	001		A Cable is allowed to consume full power from a Sink.
	"Consume Half"	010		A Cable is allowed to consume half power. from a Sink.
	"Consume & Supply"	011		A Cable is allowed to consume full power from a Sink and supply another power to a Source. [Wire] shall be "No connect"...
	"Supply only"	100		A Cable supply another power to a Source. [Wire] shall be "No connect"..
Reserved			2 bits	Set to "0"

TRANSMISSION SYSTEM AND RELAY DEVICE

INCORPORATION BY REFERENCE

The present application is a continuation application of Ser. No. 13/316,757, filed Dec. 12, 2011 which claims priority from Japanese application JP2011-050971 filed on Mar. 9, 2011, the content of which is hereby incorporated by reference into this application.

BACKGROUND OF THE INVENTION

A technical field relates to operations of power supply and reception.

JP-A No. 2009-44706, the counterpart of US Publication No. 2010/0135429, discloses "a transmission device which includes a signal transmitter for transmitting a video signal via a cable to a reception device in the form of a differential signal through a plurality of channels, an information transmitter for transmitting request information to request power supply via the cable to the reception device, and a power switch for supplying the power supplied via the cable from the reception device to an internal circuit in response to transmission of the request information from the information transmitter" (refer to JP-A No. 2009-44706, Paragraph [0017]).

JP-A No. 2009-44706 also discloses "a source device 110 which transmits request information of power supply to a sink device 120 using a CEC line of a HDMI cable 130" (refer to JP-A No. 2009-44706, Paragraph [0100]), and also discloses "a sink device 120A which supplies power to a source device 110A via a reserve line of the HDMI cable 130" (JP-A No. 2009-44706, Paragraph [0220]).

JP-A No. 2010-4510, the counterpart of US Publication No. 2008/0315291, discloses "function information is transmitted as OEC (Consumer Electronics Control) data or CDC (Capability Discovery Channel) data from a source device to a sink device or from the sink device to the source device between the source and sink devices connected through an HDMI® (High-Definition Multimedia Interface) via a CEC line as a control line" (refer to JP-A No. 2010-4510, Paragraph [0160]).

However, any of JP-A No. 2009-44706 and JP-A No. 2010-4510 fails to disclose power supply to a relay device (such as a cable or repeater device) connected between the sink and source devices.

SUMMARY OF THE INVENTION

In order to solve the above problem, such arrangements as set forth, for example, in claims are employed.

The present application includes a plurality of means for solving the above problem. As one of its examples, there is provided a system which transmits a video signal from a source device to a sink device via a relay device and in which the sink device supplies a power to the relay device on the basis of a request from the relay device.

As the employment of the above means enables power supply to the relay device installed between the sink and source devices, it improves user's convenience.

Other objects, features and advantages of the invention will become apparent from the following description of the embodiments of the invention taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** shows a block diagram showing an example of a transmission system.

FIG. **2** shows an example of a message structure in the transmission system.

FIG. **3** shows a table showing an example of messages in the transmission system.

FIG. **4** shows a table showing an example of message parameters in the transmission system.

FIG. **5** shows an example of message transmission and reception in the transmission system.

FIG. **6** shows a block diagram showing an example of a cable.

FIG. **7** shows an example of message transmission and reception in the transmission system.

FIG. **8** shows a table showing an example of message parameters in the transmission system.

FIG. **9** shows a table showing an example of message parameters in the transmission system.

FIG. **10** shows a table showing an example of message parameters in the transmission system.

FIG. **11** shows an example of message transmission and reception in the transmission system.

FIG. **12** shows an example of message transmission and reception in the transmission system.

FIG. **13** shows a block diagram showing an example of a cable.

FIG. **14** shows a table showing an example of device information description.

FIG. **15** shows a table showing an example of message parameters in the transmission system.

FIG. **16** shows a block diagram for explaining an example of wireless transmission.

FIG. **17** shows a table showing an example of message parameters in the transmission system.

DESCRIPTION OF THE EMBODIMENTS

Embodiments of the present invention will be explained.

Embodiment 1:

FIG. **1** is a block diagram showing an example of a transmission system of this embodiment, in which a source device **11** is connected to a sink device **21** via a cable **32**, a power is supplied from the sink device to the source device, and a video signal is transmitted from the source device to the sink device.

The source device **11** is a video signal transmitting device such as a disk player, a disk recorder, a semiconductor recorder, a broadcasting receiver, a game machine, or a personal computer (PC). The source device **11** has a reproducer **111** for reproducing a video signal from data obtained from a storage medium such as an optical disk, a magnetic recording disk or a semiconductor memory or from a network; a video transmitter **112**; an EDID (Extended Display Identification Data) reader **113**; a CEC (Consumer Electronics Control) communication unit **114**; a voltage detector **115**; a DDC (Display Data Channel)+5V supplier **116**; an HPD (Hot Plug Detect) detector **117**; a controller **118**; and a power supply circuit **119**.

The sink device **21** is a video signal reception device which includes such a display device as a liquid crystal display, a plasma display, an organic EL display. The sink device **21** further includes a display **211**, a video receiver **212**, an EDID memory **213**, a CEC communication unit **214**, a current limiter **215**, an HPD output **216**, a controller **217**, a power supplier **218**, and a power supply circuit **219**. In this connection, the sink device **21** may have such an arrangement as to include a tuner, a descrambler, a demultiplxer, a decoder or a video recording function for processing broadcast waves

received at an antenna, and as to be capable of reproducing video contents only with the sink device alone.

The cable **32** is a cable for connecting between connectors **312** to **317** of the source device and connectors **332** to **337** of the sink device, and is, for example, an HDMI **0** converter cable. The cable **32** has an electrical to optical converter **321**, a optical to electrical converter **322**, an optical fiber **327**, an EDID acquirer **323**, a CEC communication unit **324**, a controller **325**, and a power supply circuit **326**.

An example of the structure of a message for exchange among the CEC communication unit **114**, the CEC communication unit **214**, and CEC communication unit **324** is shown in FIG. **2**. As shown in Patent Document 2, a CDC message is defines as one of CEC messages, which includes start bit showing the header of the message, followed by CEC header block having logical and physical addresses of transmission and reception devices of the message, CEC opcode block indicative of being CDC message, initiator physical address indicative of physical address of the message transmission device, CDC opcode indicative of type of the CDC message, and CDC parameter indicative of a parameter of the CDC message.

Explanation will be made in connection with the CDC message as an example. However, the present invention is not limited to the structure of the CDC message. When the CDC opcode is defined for the CEC opcode, the CEC message may be uses in place of the CDC message. Further, a bidirectional communication message of the DDC (Display Data Channel) or HDMI Ethernet channel for use in EDID reading may be also employed.

In the HDMI® system, a source device having an output terminal, a sink device having an input terminal, and a repeater device having output and input terminals have different physical addresses in principle, but a cable usually has no physical address. Several description manners of the initiator physical address are considered for the CDC message issued from a cable acquiring no physical address.

For example, the physical address of a source device shown in the EDID of a sink device is considered to be written in the initiator physical address of the CDC message transmitted from a cable. For another example, "FFFF" may be allocated to the initiator physical address, and information corresponding to the physical address of the source device may be described in the parameter of the CDC message.

The latter has a merit that, since the parameter of the CDC message becomes long with a result of a good communication time but the cable uses a physical address different from the source device, a risk of erroneous operation of the source device becomes small. In the following description of the embodiment, the former will be employed.

FIG. **3** is a table showing an example of a CDC message. In the table, <CDC_Power_Request> is a message for the source device to require such current supply as shown by a parameter [Power_Source] to the sink device (and/or the cable).

<CDC_Power_Status> is a message for the sink device to inform the source device (and/or the cable) of start of such current supply as shown by a parameter [Power_Sink]. <CDC_Power_Notice> is a message for the sink device to previously notify the source device (and/or the cable) of a change in such supply current as shown by a parameter [Power_Sink].

<CDC_Power_Request_C> is a message for the cable to require such a current supply as shown by a parameter [Power_Cable] to the sink device. <CDC_Power_Notice_C> is a message for the cable to previously notify power stoppage to the source device during power supply from a unique power source other than the power supply from the sink device to the source device.

FIG. **3** shows responses to the respective messages if destination devices support the functions of the present invention.

In FIG. **3**, further, when different message names (that is, different opcodes) for requesting power supply are used for the source device and the cable, one of the messages which is issued from one of the source device and cable can be distinguished from the other, even if a common physical address is used in the initiator physical address for the source device and the cable. This may be defined in such a manner that the message name is commonly used to the source device and the cable and different device types are added in their parameters to be distinguishable between the source device and the cable.

A distinction between the source device and the cable may also be made in such a manner that the number of parameters is changed, for example, the request current of a source device is described for the source device, and the request current of the cable a current capable of being supplied to the source device are described for the cable.

FIG. **4** is a table showing an example of message parameters. [Power_Source] indicates need or no need of power supply by 1 bit. [Power_Sink] is made of [Input Port Number] of 4 bits corresponding to numbers of input terminals for power supply, [P_Source] of 2 bits indicative of the status of power supply to the source device, and [P_Cable] of 2 bits indicative of the status of power supply to the cable.

[Input Port Number] is expressed by 4 bits corresponding to the input terminal numbers of the sink device, which indicate the physical address of a source device as a connection destination when combined with the initiator physical address in the CDC message. The input terminal number may be replaced with the physical address (that is, the physical address written in the EDID of the corresponding input terminal) of 2 bytes of the connection destination. In order to suppress the message length and shorten a communication time, however, the use of the input terminal number of 4 bits is desirable.

[P_Source] includes "No Power" indicative of no power supply to the source device, "Half Power" indicative of supply of half of a predetermined power, "Power_S" indicative of supply of the predetermined power from the sink device, and "Power_C" indicative of supply of the predetermined power from a power source provided in the cable independently of the sink device. [P_Cable] includes "No Power" indicative of no power supply from the sink device to the cable, "Half Power" indicative of supply of half of the predetermined power, and "Full Power" indicative of supply of the predetermined power.

[Power_Cable] is made up of [Wire] of 3 bits indicative of whether or not utility terminals at both ends of the cable are connected so that the power can be supplied, [P_Source] of 2 bits indicative of the status of power supply to the source device, and [P_Cable] of 2 bits indicative of the status of power supply to the cable. [Wire] indicates a connection status "Connect" and a no connection status "No Connect". [P_Source] and [P_Cable] have the same meanings as in the aforementioned parameter [P_Source] and thus explanation thereof is omitted herein.

In FIG. **4**, such a status that the power from the sink device is divided into halves by the source device and the cable, is defined. For simplicity of the explanation, however, it is obvious that such a status may be removed and such an exclusive control may be provided that, when one of the source and sink devices receives the power, the other device cannot receive it.

FIG. **5** shows an example of message transmission and reception. Explanation will be made as to the operation of a transmission system by referring to FIGS. **1** to **5**.

First of all, a power, e.g., 5V, 65 mA for booting the transmission system is supplied from the power supplier **218** of the sink device **21** to the power supply circuit **119** of the source device **11** via the current limiter **215**, a utility terminal **335**, the cable **32** and a utility terminal **315** (step **701**).

The power supply circuit **119** of the source device **11** supplies a power to the HPD output **216** and the power supply circuit **219** of the sink device **21** through a DDC+5V supplier **116**, a DDC+5V terminal **316**, the cable **32** and a DDC+5V terminal **336** (step **702**).

The HPD output **216**, when receiving the power, sends a logical level indicative of completion of cable connection, e.g., "H" to the HPD detector **117** of the source device **11** through the HPD terminal **337**, the cable **32** and the HPD terminal **317** (step **703**).

Cable connection information detected by the HPD detector **117** is informed to the controller **118**, which in turn instructs the EDID reader **113** to read out the EDID. The EDID reader **113** reads out the EDID having information about the reception capability of the sink device written therein from the EDID memory of the sink device **21**, acquires the information, and then informs the controller **118** of the information (step **704**).

At this time, the EDID acquirer **323** of the cable **32** monitors a signal on the cable, and acquires information required at least by the cable **32** in the EDID acquired by the source device, for example, information or the like relating to the physical address of the source device expressed in a combination of the physical address of the source device and the input terminal number connected by the cable. In this way, the source device **11** and the cable **32** acquire the physical address of the source device from the EDID (step **705**).

The power supplied from the power supplier **218** is divided, for example, into maximum 5 mA (supplied from the HPD terminal **335**) for the operation of a circuit block in the cable **32**, maximum 5 mA for the operation of a circuit block in the source device **11**, and 55 mA outputted from a DDC+ 5V terminal **316** to the cable **32** and also to the sink device **21** from the source device. A power, 5V, maximum 55 mA, supplied from the DDC+5V supplier **116** is defined according to DDC Standards, that is, the power supplied from the DDC+ 5V supplier **116** is used so that the source device returns 5 mA from the DDC+5V terminal **316** to the cable **32** and returns 50 mA to the sink device **21**.

Thus, when the sink device **21** supplying the system booting power from the utility terminal **335** defines a consumption current from a DDC+5V terminal **336** as maximum 10 mA, and when lacking maximum 40 mA is interchanged within the power supply circuit **219**; a current flowing through the cable can be reduced and thus a power loss can be advantageously suppressed. In this case, a power to be supplied from the utility terminal **335** of the sink device for booting the transmission system becomes a total of 25 mA, that is, maximum 5 mA for the source device, maximum 10 mA for the cable (5 mA from the utility terminal and 5 mA from the DDC+5V terminal), and maximum 10 mA (to be supplied from the DDC+5V terminal to the HPD output **216** and to the EDID memory **213**) for the sink device.

A message <CDC_Power_Request_C>["Connect", "No Power", "Full Power"] **706** for requiring the sink device **21** to supply a necessary power necessary for the cable **32** sends from the CEC communication unit **324** of the cable **32** to the CEC communication unit **214** of the sink device **21**. For simplicity of the subsequent explanation, "CEC communication unit" is omitted and description is made simply by "the message is sent from the cable **32** to the sink device **21**". The message **706** can be received even at the source device **11**. However, since there is no change in the power reception status of the source device **11**, and in particular, since internal control operation or response is not required, the message **706** directed toward the source device is shown by a dashed-line arrow.

The power supplier **218** of the sink device **21** supplies, e.g., 5V, 500 mA to the power supply circuit **326** of the cable **32** via the utility terminal **335** (step **707**). The sink device **21** informs the cable **32** of a message <CDC_Power_Status>["1", "No Power", "Full Power"] **708** to inform start of supply of a power to the cable **32**, so that the power supply circuit **326** of the cable **32** starts to use 500 mA (step **709**). In this case, it is assumed that the cable **32** is connected to an input terminal number **1** (not shown) of the sink device **21**.

The power supply circuit **326** supplies a power to the electrical to opticalelectrical to optical converter **321** and also to the optical to electrical converter **322**. With this, a video output of the reproducer **111** is output from the video transmitter **112** to a video terminal **312** in the form of an electric video signal, is converted by the electrical to opticalelectrical to optical converter **321** to an optical video signal, and then sent to the optical to electrical converter **322** by the optical fiber **327**. The transmission of the optical signal through the optical fiber enables easy transmission of the optical signal by a distance longer than the transmission of an electric signal. The optical signal is converted by the optical to electrical converter **322** to an electric video signal, and then outputted to a video terminal **332**. The video receiver **212** receives the output electric video signal and displays it on the display **211** in the form of a video.

When it is desired for the source device **11** to receive a power, the source device sends a message <CDC_Power_Request>["Need"] **710** to the sink device **21** and also to the cable **32**. The sink device, which is supplying a power to the cable, returns a message **711** <CDC_Power_Status>["1", "No Power", "Full Power"] indicating that the sink device cannot supply a power to the source device **11**, to the source device **11**. At the same time, the source device informs the source device **11** and the sink device **21** of the fact that the cable **32** is using a power, with use of a message **712** <CDC_Power_Request_C>["Connect", "No Power", "Full Power"].

Since the message **712** is the same as a message by which the cable requests power supply, the message **712** to the sink device is overlapped with the message **711**. However, the sink device returns a message <CDC_Power_Status>["1", "No Power", "Full Power"] **713** to the cable **32**. In order to avoid the overlap of the messages **711** and **713**, the message **711** can be omitted when the message **712** is first sent as a response message to the message **710**. To this end, the response message to the message **710** may be set so that the sink device **21** issues the message later than the cable **32** by prolonging the bus idle monitor time of the sink device or by returning the message after a predetermined time, e.g., about 0.1 seconds.

At this time, the sink device **21** may respond to the message **711** with a message <CDC_Power_Notice>["1", "Half Power", "Half Power"] indicative of previous notification of a change in power distribution, and may respond to it with the message **712** for the cable **32** to request the continuous supply sustainment of full power.

In this way, it is desirable in principle that the power supplying side determine power distribution instruction and power distribution to the currently-power-receiving device be preferential. Further, when a device receiving a power to be used and the power becomes unnecessary, it is preferable in

principle that the power supply be quickly returned to increase an opportunity of power supply to a necessary device.

When the cable **32** stops its power use as when the transmission of a video signal is completed (step **714**), the cable **32** sends a message **715** <CDC_Power_Request_C>["Connect", "No Power", "Full Power"] indicative of power reception stoppage to the sink device. The sink device stops the power supply (step **716**), and informs the source device **11** and the cable **32** of the fact with the message <CDC_Power_Status>["1", "No Power", "No Power"] **711**.

Even when the source device **11** transmits no video signal, the source device, for example, when the source device is a mobile device, may need a power in order to charge a built-in secondary battery. The source device **11** transmits a message <CDC_Power_Request>["Need"] **718** to the cable **32** and to the sink device **21**. When the cable **32** is connected to a utility line to supply a power and it is unnecessary for the cable **32** in turn to use the power continuously, a response is not necessary in particular. However, the cable may respond to it with a message <CDC_Power_Request_C>["Connect", "Power_S", "No Power"] (not shown).

The sink device **21** starts supply of a predetermined power, 5V, 500 mA (step **719**), and informs the source device **11** of start of the power supply with a message **720** <CDC_Power_Status>["1", "Power_S", "No Power"], and the source device **11** starts use of the predetermined power (step **721**).

When the sink device **21** uses another function using the utility line, for example, when the sink device uses transmission of a packet signal or a voice signal or when it is desired to stop the power supply through user's operation; the sink device informs the source device **11** of the fact with a message <CDC_Power_Notice>["1", "No Power", "No Power"] **722**. The source device is put in its power use stopping operation. When a time for backup or the like becomes necessary in the power stopping operation, the source device transmits a message <CDC_Power_Request>["Need"] **723** to require the continuous power supply to the sink device **21**.

When the sink device **21** continuously supplies the power, the sink device transmits a message (not shown)<CDC_Power_Status>["1", "Power_S," "No Power"] to the source device. When the sink device performs its power supply stopping operation, however, the sink device sends a message <CDC_Power_Notice>["1", "No Power", "No Power"] **724** to the source device **11** at time intervals of a predetermined time, e.g., 5 seconds. In case of emergency as when the main power switch of the sink device **21** is turned OFF or the like, the sink device **21** suddenly may stop its power supplying operation without issuing the message **724**. Thus, such a situation has to be beforehand considered to the source device **11**.

The source device **11**, after stopping its power supply (step **725**), transmits a message <CDC_Power_Request>["No Need"] to the sink device **21**. The sink device, after stopping its power supplying operation (step **727**), sends a message <CDC_Power_Status>["1", "No Power", "No Power"] indicative of stoppage of the power supply to the source device **11**. In this connection, even in the case of the power supply stoppage, when it is intended for the sink device to reboot the transmission system, the sink device can continuously supply a power of about 5V, 65 mA or 25 mA as a booting standby power (step **701**).

When the source device receives the power supply, an electric wire connecting between the utility terminal **335** and **315** may have high resistances, so that a voltage applied to the source device **11** becomes too low compared to an output voltage of the sink device **21**, in some cable **32**. For example, assume now that the electric wire has a resistance of 5Ω and a supply current is 500 mA with respect to an output 5V of the sink device **21**. Then it is considered that a voltage drop of 2.5V occurs and a voltage applied to the source device **11** becomes 2.5V.

As a result, the voltage drop may possibly cause erroneous operation of the source device or troubles including heat generation in the cable. To avoid this, the voltage detector **115** is required to be provided in the source device **11** so that, when the predetermined voltage is not higher than, e.g., 4V, the controller **118** receiving the detection result of the voltage detector **115** controls the power supply circuit **119** to suppress or stop the use power. In addition, when a current limiter having a margin value of about 10% of a predetermined maximum current supply is provided even in the sink device **21**, a protection function is further enhanced.

In this way, the sink device supplies power not only to the source device but also to the cable requiring an external power. Then, long-distance transmission using optical fiber or the like becomes much easier to use because a special power source is not necessary Explanation has been made in connection with the cable as an example.

However, some of HDMI® repeater devices copy an EDID shown by the sink device and transmit it to the source device, so that the physical address of the source device is overlapped with the physical address of the repeater device. Even such a repeater can receive power supply by using such a message for the active cable as mentioned above.

Embodiment 2:

Another embodiment of the transmission system in accordance with the present invention will be explained by referring to FIGS. **6** and **7**. FIG. **6** is a block diagram of a part of a cable. A cable **34** is replaced by the cable **32** of FIG. **1**, and includes a source device **11** and a sink device **21** both having similar structures to those in FIG. **1**, and therefore the structures are not illustrated.

In FIG. **6**, blocks having the same or equivalent functions are denoted by the same reference numerals. FIG. **6** is different from FIG. **1** in that a switch **341** is added between DDC terminals **313** and **333** for reading out EDID information; a utility terminal **315** is separated from a utility terminal **335**, power supply circuits **343** and **326** are provided to the respective separated utility terminals; a DDC+5V terminal **316** is separated from the DDC+5V terminal **336** and an DDC+5V terminal **317** is separated from an DDC+5V terminal **337**, an HPD output **344**, an HPD detector **346**, and a DDC+5V supplier **345** are added to the separated DDC+5V and HPD terminals.

A message structure, a message type, and message parameters in the embodiment 2 are the same as message structure (FIG. **2**), message type (FIG. **3**), and message parameters (FIG. **4**) in the embodiment 1. FIG. **7** shows an example of message transmission and reception.

The sink device **21** supplies a power of, e.g., +5V, maximum 25 mA as a standby power to the power supply circuit **326** of the cable **34** via the utility terminal **335** (step **801**). The power supply circuit **326** of the cable **34** supplies a power of +5V to the sink device **21** via the DDC+5V supplier **345** (step **802**). The sink device **21** changes the level of the DDC+5V terminal **337** from "L" to "H" (step **803**).

The HPD detector **346** of the cable **34** detects the level change and informs the controller **325** of the level change. After the controller **325** turns OFF the switch **341**, the EDID acquirer **323** reads out the physical address of the source device included in the EDID information of the sink device **21** and acquires the read-out physical address (steps **804** and **805**).

In the embodiment 1, when the source device reads out the EDID of the sink device, the EDID acquirer intercepts the read-out signal. In the present embodiment, however, since the source device boots the transmission system prior to start of EDID reading operation, the EDID acquirer of the cable **34** is set to be able to singly read out the EDID information. At this time, in order to prevent of erroneous operation of the EDID reader of the source device, the switch **341** is provided.

Accordingly, the switch **341** is set at its OFF state in a time period during which the source device **11** does not read out the EDID and the cable **34** singly performs its EDID reading operation. In a time duration other than the EDID reading operation period of the cable **34** alone, the switch **341** is put in its connected state. When the cable length is long, provision of a buffer between the DDC terminals **313** and **333** enables increased reliability of DDC communication.

The cable **34**, after acquiring the physical address, sends a message <CDC_Power_Request_C>["No Connect", "No Power", "Full Power"] **806** requiring power supply to the sink device **21**. The sink device **21** starts supply of a power of, e.g., +5V, maximum 500 mA from the utility terminal **335** to the power supply circuit **326** of the cable **34** (step **807**). The sink device sends a message <CDC_Power_Status>["1", "No Power", "Full Power"] to the cable **34** to inform the cable of start of the power supply. The cable **34** starts use of the power of +5V, maximum 500 mA (step **809**) to put the optical to electrical converter **322** in its signal reception preparing operation.

The source device **11** is activated and supplies a power of, e.g., 5V, maximum 55 mA to the DDC+5V terminal **316** (step **810**). The power supply circuit **343** supplies its power to the electrical to optical converter **321**, and the HPD output **344** changes the level of the DDC+5V terminal **317** from "L" to "H" only while the HPD detector **346** detects the fact that the DDC+5V terminal **337** is at "H" level (step **811**).

Since the EDID information cannot be read out from the EDID memory of the sink device **21** during "L" level of the HPD terminal **337**, the HPD terminal **317** is kept at the "L" level. When the HPD terminal is changed to the "H" level, the source device **11** reads out the EDID information of the sink device **21** through the DDC terminal **312** and **333** (steps **812**, **813**). At this time, the EDID acquirer **323** of the cable **34** intercepts the EDID information, confirms information associated with the physical address of the source device **11**, and if there is a change therein, then acquires the changed information. On the basis of the latest information, message transmission and reception are carried out.

When the source device **11** sends a message <CDC_Power_Request>["Need"] **814** to request power supply, the sink device **21**, which is already supplying power to the cable **34** and has no allowance for the power supply, responds to it with a message <CDC_Power_Status>["1", "No Power", "Full Power"] **815** to disable the power supply.

Not only when the source device has no allowance for the power supply but also when no connection of the utility line is already known from the message **806**, the sink device responds to it with the same message **815** indicative of the disabled power supply. When no connection of the utility line is not known and when no power is supplied to the cable, the sink device responds to it with a message <CDC_Power_Status>["1", "Power_S", "No Power"] (not shown) at the same time as the start of the power supply.

When the cable **34** when receiving the message **814**, receives power supply at the power supply circuit **343** from a not shown power source; starts power supply to the source device **11** (step **816**), and also informs the source device **11** and the sink device **21** of the fact, with the message <CDC_Power_Request_C>["No Connect", "Full Power", "Full Power"] **815**.

The sink device **21** issues a message <CDC_Power_Status>["1", "Power_C", "Full Power"] **817** to confirm the power supply status, and the source device starts use of a power of +5V, maximum 500 mA (step **818**). If the power supply status is different, then the source device **11** or the cable **34** issues a power request message for its medication.

When it is desired for the sink device **21** to stop the power supply through user's operation of the sink device **21** or the other means, the sink device issues a message <CDC_Power_Notice>["1", "Power_C", "No Power"] **819**. The cable **34**, when receiving a power supply stop request, accepts a power supply stoppage from the sink device **21**, and issues a message <CDC_Power_Notice_C>["No Connection", "No Power", "No Power"] **821** to previously notify the source device **11** to the power supply stoppage.

The cable **34** responds to it with a message <CDC_Power_Request_C>["No Connect", "Power_C", "Full Power"] when the cable **34** does not accept the power supply stoppage from the sink device **21**, and responds to it with a message <CDC_Power_Notice_C>["No Connect", "No Power", "Full Power"] when it is desired to firstly stop power supply to the source device.

The sink device **21** regards the cable **34** as having accepted the power supply stoppage and stops the power supply (step **821**). At the same time, the sink device responds to it with a message <CDC_Power_Status>["1", "Power_C", "No Power"] **822**.

When the source device **11** wants to request power supply continuation in response to the message **821**, the cable issues a message <CDC_Power_Request>["Need"] **823** for the continuation request. A response message of the source device **11** to the same message **823** becomes the message <CDC_Power_Status>["1", "Power_C", "No Power"] **822**.

When it is desired for the cable **34** to continuously stop the power supply to the source device **11**, the cable issues a message <CDC_Power_Notice_C>["No Connection", "No Power", "No Power"] **824** at intervals of a predetermined time, e.g., about 5 seconds or more. When the source device **11** stops the use of a power, +5V, maximum 500 mA (step **825**), the source device sends a message <CDC_Power_Request>["No Need"] **826** to the cable **34** and also to the sink device **21**.

In response to it, the sink device **21**, the sink device **21** issues a message <CDC_Power_Status>["1", "No Power", "No Power"] **827**. The cable **34**, on the other hand, stops supply of the power of +5V, maximum 500 mA, to the source device **11** (step **828**), and responds to it with a message <CDC_Power_Request_C>["No Connect", "No Power", "No Power"] **829**.

As a response to the message **829**, the sink device **21** issues the message <CDC_Power_Status>["1", "No Power", "No Power"] **827** to confirm the current status. In this connection, when the cable **34** issues the message **829** before the sink device **21** issues the message **827**, the message **827** may be omitted and it may be replaced with only a message **830**. When the timing of issuing the message **827** is set to be later than the usual response, for example, by about 0.1 seconds, the possibility of omitting the message **827** can be increased and heavy traffic of the message communication channel can be avoided.

As has been mentioned above, since the power supply from the sink device to the cable and the power supply from a cable having an independent power source to the source device can be obtained, the system can be operated even when the cable

has, at its sink device side, an insufficient power source and the source device has an insufficient power source, thus improving its the convenience of use.

Embodiment 3:

A flexible embodiment capable of adjusting a current supply amount stepwise will be shown. In the present embodiment, a block diagram of a transmission system, a message structure and a message example are substantially the same as those in FIGS. **1**, **2** and **3** explained in the embodiment 1, and explanation thereof is omitted.

In place of parameters in FIG. **4**, message parameters defined in FIGS. **8**, **9** and **10** are used. A maximum current use amount [Source_Current] for a source device a maximum current use amount [Cable_Current] for a cable are prepared respectively to have 5 sorts of 125 mA units in a range of 0 and 500 mA and a type of 5 mA as a standby mode. A maximum current supply amount [Sink_Current] for a sink device are set to be stepwise incremented by 25 mA so that 25 mA can be incrementally added as a standby current.

In this case, "0 mA" in [Sink_Current] indicates that a current supply capability is smaller than 25 mA, and has no capability of supplying the standby power. In the present embodiment, the supply voltage is assumed to be +5V. However, any other voltage can be employed so long as the supply voltage is previously set. Further, similarly to the maximum current parameter, even voltage settings may be defined as combinations between arbitrary voltages and maximum currents by adding to parameters.

In the standby mode, 5 mA is assumed for the internal controller of each of the source device and the cable as a standby power source, a power in a range of (DDC+5V) to 10 mA is assumed as EDID reading for the sink device, and a preliminary current 5 mA prescribed in the DDC Standards (the source device supplies 55 mA and the sink device use maximum 50 mA) is added so that the sink device has a supply current of 25 mA.

In addition, check sum is provided for each message and a message having an incorrect check sum is ignored. Thus, when a predetermined response message cannot be obtained, the message is again transmitted. As a result, a transmission system having a high reliability can be obtained. A parameter [Power2] shown in FIG. **10** indicates that power supply is made from an independent power source having a cable section to a source device. Since the other parameters are substantially the same as those in FIG. **4**, detailed explanation thereof is omitted.

FIG. **11** shows an example of message transmission and reception. The operation of the example will be explained by referring to FIG. **11**. In the drawing, explanation of a parameter [Check_sum] is omitted. Steps until the source device **11** and the cable **32** acquire physical addresses are substantially the same as the steps of FIG. **5** already explained in the embodiment 1, and explanation thereof is omitted.

The cable **32** sends a message <CDC_Power_Request_C> ["Connect", "None", "150 mA", "5 mA", "125 mA"] **736** to the sink device **21** to request a power supply of 125 mA, and the sink device **21** starts supply of maximum 150 mA (step **737**). The sink device informs the cable **32** and the source device **11** of the fact of the started supply of maximum 150 mA to the cable, with a message <CDC_Power_Status>["1", "150 mA", "5 mA", "125 mA"] **738**. A supply start current to the sink device **21** is set to have any value so long as the supply start current is not lower than a requested value. For example, supply of a more current may be set so that the sink device issues a message <CDC_Power_Status>["1", "525 mA", "5 mA", "125 mA"] or a message <CDC_Power_Status>["1", "400 mA", "125 mA", "250 mA"]. The cable **32**, when receiving the message **738**, starts the use of a current of maximum 125 mA (step **740**).

In the message **736**, when a total of maximum currents to be consumed by the source device and the cable exceeds the maximum supply current of the sink device (except when the cable has its own power source) and when [Check sum] is incorrect; the sink device does not start the current supply, or starts supply of an amount of current appropriately estimated and sends a corresponding response message. Similarly, in the message **738**, when a total of maximum currents to be consumed by the source device and the cable exceeds the maximum supply current of the sink device and when [Check sum] is incorrect; the cable **32** again transmits the message <CDC_Power_Request_C>["Connect", "None", "150 mA, "5 mA", "125 mA"] **736** to the sink device **21**, thus increasing the reliability of the current supply of the transmission system.

The source device **11** next transmits a message <CDC_Power_Request>["525 mA", "375 mA"] **740** to the sink device **21** to request current supply of maximum 375 mA. The sink device **21** starts supply of a current not smaller than a total value, e.g., 525 mA of 125 mA of the cable and 375 mA of the source device (step **741**), and notifies the source device **11** and the cable **32** of the fact, with a message <CDC_Power_Status>["1", "525 mA", "375 mA", "125 mA"] **742** to designate the maximum use current values of the source device and the cable. In response to the notification, the source device **11** starts use of the current of 375 mA (step **743**).

For example, when the source device **11** stops video output and uses the current so far used for video transmission of the cable in order to speed up charging of a built-in optical battery; the source device sends a <CDC_Power_Request> ["500 mA", "500 mA"] message **744** to the cable **32** and the sink device **21** to request a current of 500 mA.

The cable **32** stops use of a current of 125 mA, uses only a standby current of 5 mA (step **745**)), and sends a message <CDC_Power_Request_C>["Connect", "None", "525 mA", "500 mA", "5 mA"] **746** indicative of direction of 500 mA among the supply current of 525 mA of the sink device **21** to the source device **11**, to the sink device **21**.

The sink device **21** sends a message <CDC_Power_Status>["1", "525 mA", "500 mA", "5 mA"] **747** to the source device **11** to confirm the message **746** from the cable **32**, and the source device **11** in turn, when receiving the message **747**, starts use of the current of 500 mA (step **749**).

When it is desirable for the cable **32** to stop the current supply to the source device **11**, sends a message (not shown) <CDC_Power_Notice_C>["Connect", "None", "25 mA", "0 mA", "5 mA"] to the source device **11** or sends a message <CDC_Power_Request_C>["Connect", "None", "25 mA", "0 mA", "5 mA"] **749** to the sink device **21**, and informs the source device **11** of the fact, with a message <CDC_Power_Notice>["1", "25 mA", "0 mA", "5 mA"] **750** as a response message to the sink device **21**.

When it is desirable for the source device **11** to continue the current use, the source device **11** informs the sink device and the cable of the fact, with a message <CDC_Power_Request> ["525 mA", "500 mA"] (not shown). When it is desired for the source device **11** to stop the current use (step **751**), the source device **11** informs the sink device **21** of the fact, with a message <CDC_Power_Request>["25 mA", "0 mA"] **752**.

The sink device **21** reduces the supply current from 525 mA to 25 mA, and informs the source device **11** and the cable **32** of the fact, with a message <CDC_Power_Status>["1", "25 mA", "0 mA", "5 mA"] **754** indicative of the current status as a response message.

In accordance with the present embodiment, since a current supply amount of the sink device can be flexibly adjusted according to a current use amount of the source device or the cable, a power use efficiency of a power supply part or a power supply circuit in the sink device can be advantageously increased and the power consumption of the sink device can be advantageously reduced. Further, when interchange is made flexibly between the use currents of the source device and the cable, the full potential of the functions of the source device and the cable can be utilized.

Embodiment 4:

FIG. **12** shows another example of the message transmission and reception when the cable **34** of FIG. **6** used in the explanation of the Embodiment 2 is combined with message parameters in FIGS. **8** to **10** used in the explanation of the Embodiment 3. Similarly to FIG. **11**, description of the parameter [Check sum] is omitted. In FIG. **12**, steps **841** to **853** until the source device **11** and the cable **34** acquire their physical addresses are substantially the same as those of FIG. **7** explained in the Embodiment 2, except that a step **850** of supplying a standby power of, e.g., +5V, 25 mA, to the utility terminal **315** from its own power source of the cable **34** is added.

Addition of the power supply step **850** enables the supply power of the cable **34** to the utility terminal can be used for the supply power of the source device **11** to the DDC+5V terminal **316**.

When the source device requires a current of 500 mA, the source device sends a message <CDC_Power_Request> ["525 mA", "500 mA"] **855** to the cable **34** and to the sink device **21**, without paying any consideration of a special situation as when the cable has its own power source therein or when the utility line is not connected. Since the sink device **21** acquires the fact of disconnection of the utility line of the cable **34** on the basis of a message **846**, adjustment based on the message <CDC_Power_Notice>["1", "525 mA", "375 mA", "125 mA"] is difficult. Thus the sink device **21** responds to it with a message <CDC_Power_Status>["1", "125 mA", "5 mA", "125 mA"] **856** indicative of the current distribution.

The cable **34** having its own power source, on the other hand, starts a current of 525 mA to the source device in response to the message **855** indicative of current request of the source device (step **857**), and thereafter issues a message <CDC_Power_Request_C>["No Connect", "Independent", "150 mA", "500 mA", "125 mA"] **858** to the sink device to inform it of the fact. The sink device **21** in turn sends a message <CDC_Power_Status>["1", "150 mA", "500 mA", "125 mA"] **859** as a response message to confirm its status to the source device **11**, and the source device **11** in turn starts use of a current of 500 mA (step **860**).

When the sink device **21** became able to supply only the standby current through user's operation or the like, the sink device **21** informs the cable **34** of the fact, with a message <CDC_Power_Notice>["1", "25 mA", "500 mA", "5 mA"] **861**. When it becomes unnecessary to the power continuation supply, the cable **34** informs the sink device of the fact, with a message <CDC_Power_Request_C>["No Connect", "Independent", "150 mA", "500 mA", "125 mA"] (not shown). However, when the current can be shifted to the standby current of 5 mA, after the shift (step **862**), the cable sends a message <CDC_Power_Request_C>["No Connect", "Independent", "25 mA", "500 mA", "5 mA"] **863** to the sink device **21**. The sink device **21** changes the current status to a status of supply of the standby current of 25 mA (step **864**), and sends a message <CDC_Power_Status>["1", "25 mA", "500 mA", "5 mA"] **865** to confirm the current status.

When it is desirable for the cable **34** to stop the current supply to the source device **11** due to provision of its own power source, the cable sends the message <CDC_Power_Request_C>["No Connect", "Independent", "25 mA", "0 mA", "5 mA"] **8631** to the sink device **21**. In response to a change request of the cable **34** to the supply current to the source device **11**, the sink device sends a prior notice message <CDC_Power_Notice>["1", "25 mA", "0 mA", "5 mA"] **8641** to the source device **11**.

The source device stops the current use of 500 mA (step **865**), and returns a <CDC_Power_Request>["25 mA", "0 mA"] message **866**. As its response, the sink device sends a <CDC_Power_Status>["1", "25 mA", "0 mA", "5 mA"] message **867** to confirm the status. The cable **34**, after receiving the message **866** or **867**, stops the current supply of 525 mA to the source device **11**.

The present embodiment has a merit that the need for using a <CDC_Power_Notice_C> message can be eliminated and thus the number of types of messages to be prepared can be reduced.

As has been explained above, in accordance with the present embodiment, even when the cable has its own power source, the supply current can be adjusted between the sink and source devices, thus enabling formation of a transmission system having a good handleability.

Embodiment 5:

FIG. **13** shows a block diagram of a cable in another embodiment. In the drawing, an optical transmitter **41** is connected to an optical receiver **51** by a cable therebetween, the cable including optical fibers **422** and **423** and a bundle of electric wires **425**. Connection between the optical transmitter **41** and a source device **11** and connection between the optical receiver **51** and a sink device **21** are made by simple cables. The "simple cable" means not such a cable **32** or **34** as to consume a current but such a cable that corresponding terminals at both end plugs are electrically connected to each other by electric lines. When the optical transmitter **41** has such its own power source as an AC adaptor or when the cable can be operated only with a power received from the source device, the electric wire bundle **425** can be removed.

The optical transmitter **41** includes a video receiver **412**, a multiplexer **411**, an electrical to optical converter **420**, a optical to electrical converter **421**, a DDC communication unit (including an EDID memory) **413**, a CEC communication unit **414**, a controller **417**, a current limiter **415**, a power supply circuit **419**, and an HPD output **416**.

The video receiver **412** receives a video signal received from the source device **11**, the multiplexer **411** multiplexes the video signal with control information and so on received from the controller. The multiplexer may have a function of receiving 3 primary color signals of RGB in parallel and converting the signals in a single serial signal. An output signal of the multiplexer **411** is converted by the electrical to optical converter **420** to an optical signal and sent to the optical receiver **51** via the optical fiber **422**.

The control information applied to the multiplexer **411** includes control operational information of the optical receiver **51**, reception information of the CEC and DDC communication units **414** and **413**. The optical to electrical converter **421** converts an optical signal transmitted from the optical receiver via the optical fiber **423** to an electric signal, transmits the electric signal to the controller **417** to be used at the CEC and DDC communication units **414** and **413** also as transmission information.

The optical receiver **51** includes a optical to electrical converter **520**, a decoder **511**, a video transmitter **512**, an electrical to optical converter **521**, a DDC communication unit

(including an EDID reader) **513**, a controller **518**, an CEC communication unit **514**, a voltage detector **515**, a power supply circuit **519**, a DDC+5V supplier **516**, and an HPD detector **517**.

The optical to electrical converter **520** converts a signal received from the optical transmitter **41** to an electric signal, and the decoder **511** decodes receives an output of the optical to electrical converter into the video signal and control information so far multiplexed. The video signal is sent from the video transmitter **512** to the sink device **21**.

The control information is sent to the controller **518** to be used as transmission information of the CEC and DDC communication units **514** and **513**. Control operational information within the optical transmitter **41** and reception information of the CEC and DDC communication units **514** and **513** are sent to the electrical to optical converter **521** via the controller **518**. The electrical to optical converter **521** converts the received information to an optical signal and then sent into the optical fiber **423**.

A major difference between FIG. **13** and FIG. **6** already explained in the Embodiments 2 and 4 is in that electric lines for DDC and CEC communication are replaced with an optical fiber for their communication and the cable bundle is simplified for easy long-distance transmission.

With respect to the DDC communication transmission in FIG. **13**, the EDID information of the sink device **21** may be transferred when the source device **11** reads out the EDID information; or such EDID information of the sink device **21** that is read out by the DDC communication unit **513** of the optical receiver **51**, is transmitted to the EDID memory **413** of the optical transmitter **41** and is stored in the EDID memory of the EDID memory **413**, may be transmitted. When it is desired to transfer the EDID information of the sink device **21** as it is, the messages and parameters already explained in the Embodiments 1 to 4 may be used as they are.

FIG. **14** shows an example when the power supply capability of a device is described in the form of EDID. A physical address ABCD to be acquired by a source device as a connection destination is shown at the fourth and fifth bytes. An area or field where a power supply capability is written is newly added at the ninth byte, and the presence or absence of the area is shown at the eighth byte, fourth bit, by a 'Power_present' flag.

When the flag is "1", description of the power supply capability is present. In principle, data other than the description of the power supply capability and than the flag indicative of the presence or absence of the same description area, are copied as they are from the EDID of the sink device and previously stored in the EDID memory of its own device.

The power supply capability description include 'Connecting position' indicative of presence of anywhere between the sink device and the source device, 'Power Type' indicative of the type of the power supply, and 'Current' indicative of an amount of maximum supply current.

In the 'Connecting position' field, a sink device is expressed by "00". When 1 is added to a read numeral, its own device can have ""01", "02", "03" in an order to be connected to the sink device. Thus, overlap between the physical addresses caused by the copying of the EDID and the unknown connection position can be avoided. When it is desired to inhibit the current consumption of the device reading "03" therein and to transmit the EDID to an upstream source device, erroneous operation can be prevented by describing "03" as it is without increasing its numeral.

The 'Power Type' field includes 'No power' indicative of incapable power supply, 'Original power' indicating when its own device has a power supply capability as when its own device has an AC adaptor, and 'Relay power' indicating when power of its own device supplied to a video output terminal and consumed is partly consumed at its own device and the remainder is supplied to another.

The 'Current' description field includes current values similarly to the parameters in FIG. **8**, which depend upon the supply capability of the sink device for the 'Relay power' type device. The 'Current' can be changed on a real time basis. However, it is preferable that switching between power supply amounts be made in the form of message exchange using the bidirectional communication path of the CEC communication unit or the like.

FIG. **15** shows an example of message parameters assuming that a plurality of devices are connected in cascade between source and sink devices. Ones of the parameters added when compared with those in FIG. **10** will be explained. Assuming to use "FFFF" having an unknown meaning so as not to be overlapped with the physical address of the source device, in the Initiator Physical Address of the CDC message, the physical address of the source device corresponding to 2 bytes is described in the first part of parameters, together with 'Connecting position' data, and the connection position of its own device can be expressed to be specified.

Since the 'Connecting position' can be expressed by 3 locations shown by 1 to 3, the 'Cable Current' is prepared by 3 locations so that use currents of 3 devices can be described. Although merely 'Cable' is shown for convenience of explanation, the 'Cable' may include a repeater device.

How messages are transacted concretely is substantially the same as in the Embodiments 1 to 4, and explanation thereof is omitted.

As has been explained above, in accordance with the present embodiment, even when a plurality of cables or repeater devices are connected in cascade between source and sink devices, settings of transmission of EDID information and settings of message exchange current supply can advantageously made automatically.

Embodiment 6:

FIG. **16** shows another embodiment. FIG. **16** is a block diagram of an example when a video signal is wirelessly transmitted from a source device **11** to a sink device **21** with use of a wireless transmitter **43** and a wireless receiver **53**. FIG. **16** is different from FIG. **13** in that a wireless transmitter **431** and a wireless receiver **531** are provided in place of electrical to optical conversion, no utility line is provided for power transmission, and a power supplier **418** such as an AC adaptor is provided within the wireless transmitter **43**. Messages, their parameters, operations, etc. are substantially the same as those in the Embodiment 5.

In this example, when a power transmitted from the source device **11** through the DDC+5V terminal can cover the power for the wireless transmitter, etc., the power supplier **418** becomes unnecessary. When transaction of messages similar to transaction of the messages for supplying currents form the sink device **21** is made by replacing the sink device **21** with the source device **11**, an amount of current supplied from the source device **11** to the DDC+5V terminal **316** can be increased over 55 mA based on the DDC standards.

In this way, when the sink device **21** or the source device **11** supplies a power, such an AC adaptor, which has been necessary within the wireless receiver or transmitter **53** or **43**, can be removed, thus advantageously improving its handleability.

Embodiment 7:

FIG. **17** shows another embodiment. FIG. **17** is a table showing message parameters, corresponding to the table of FIG. **4** in the Embodiment 1. FIG. **17** is different from FIG. **4**

in that power consumption/supply status of the source device and the cable are expressed in combination to avoid erroneous setting, and description of the cable connection position explained in the Embodiment 5 is added.

[Supply_Power] indicative of the power supply status of a sink device is expressed by "No Power" indicative no power supply, "Power for Source" indicative of power supply to the source device, "Power for Cable" indicative of power supply to the cable, and "Both" indicative of power supply each half to the source device and to the cable. Although settings are required while recognizing the power supply of the cable to the source device in FIG. **4**, its operation becomes unnecessary and thus the operation of the sink device becomes light in the example of FIG. **17**.

[C_Power] indicative of cable power consumption and supply is expressed by 5 status, that is, "None" indicative of no power consumption of the cable, "Consume Full" indicative of use of full or maximum power of the sink device, "Consume Half" indicative of use of half the power, "Consume & Supply" indicative of supply of the power from another AC adaptor to the source device while using the power from the sink device, and "Supply only" indicative of no use of the power from the sink device and supply of the power to the source device.

In the [Connecting Position] indicative of information on cable connection position, as shown in the Embodiment 5, memory data in the EDID is incremented by 1 for each connection.

In this method, all the cables are required to have a mechanism of incrementing the value by 1, which resulting in an increased circuit scale. To avoid this, a so-called cable having plugs at its both ends is set to only copy connection positional information at the time of EDID transmission to the next stage, and connection positional information about only a so-called repeater device having receptacles (receptacle connectors) at its both ends is incremented in units of 2. In the case of a special repeater device having a receptacle at one end and a plug at the other end, its connection information is incremented by 1.

When the connection positional information is describe in a message as positional information, with respect to the so-called cable, its connection positional information acquired from the EDID is incremented by 1, and the connection positional information of the so-called repeater device is incremented in units of 2, whereby the cable and repeater device can be distinguished from each other by [Connecting position] in the message.

An example of message exchange is substantially the same as in the Embodiment 1, and explanation thereof is omitted. In accordance with the present embodiment, less erroneous setting can be obtained and the transmission mechanism of the connection positional information can be simplified, to advantage.

In accordance with the respective embodiments, since not only power supply but also power supply of the sink device to a relay device such as a cable or a repeater device can be achieved, it becomes unnecessary to provide a power supply circuit such as an AC adaptor in the relay device, and a device having a good handleability can be provided.

Further, since a remainder power other than the consumed power of the relay device such as the cable or the repeater device or the power of its own power source provided in the relay device can be supplied to the source device, such a power supply circuit such as an AC adaptor of the source device can becomes unnecessary, and a device having a good handleability can be provided.

It should be further understood by those skilled in the art that although the foregoing description has been made on embodiments of the invention, the invention is not limited thereto and various changes and modifications may be made without departing from the spirit of the invention and the scope of the appended claims.

The invention claimed is:

1. A relay device adapted to be positioned in a transmission system for transmitting a video signal from a source device to a sink device, the relay device comprising:

a video signal receiving unit that receives the video signal from the source device;

a video signal transmitting unit that transmits the video signal to the sink device;

a first communication unit that receives a first message regarding a power supply capability of the sink device;

a second communication unit that transmits a second message regarding a power supply capability of the relay device to the source device;

a first power circuit that receives power supplied by the sink device; and

a second power circuit that supplies power to the source device;

wherein an amount of sum of the power supply capability of the relay device and power consumed at the relay device does not exceed an amount of power supply capability of the sink device, and

wherein an amount of power to be supplied from the second power circuit to the source device is arranged to be difference between an amount having been supplied from the sink device to the first power circuit and another amount consumed at the relay device.

2. The relay device according to claim **1**, wherein the amount of power having been consumed at the relay device comprises amounts of power consumed at both the video signal receiving unit and the video signal transmitting unit; and

wherein the first power circuit is arranged to transmit, to the source device, information on power supply capability of the relay device having been changed in response to other information on change of power supply capability of the sink device.

3. A method for transmitting a video signal from a source device to a sink device using a relay device, the method comprising:

receiving, at the relay device, the video signal from the source device;

transmitting, by the relay device, the video signal to the sink device;

receiving, at the relay device, a first message regarding a power supply capability of the sink device;

transmitting, by the relay device, a second message regarding a power supply capability of the relay device to the source device;

receiving, at the relay device, power supplied by the sink device; and

transmitting, by the relay device, power to the source device;

wherein an amount of sum of the power supply capability of the relay device and power consumed at the relay device does not exceed an amount of power supply capability of the sink device, and

wherein an amount of power to be supplied from the second power circuit to the source device is arranged to be difference between an amount having been supplied from the sink device to the first power circuit and another amount consumed at the relay device.

4. The method according to claim 3, wherein the amount of power having been consumed at the relay device comprises amounts of power consumed at both the video signal receiving unit and the video signal transmitting unit; and

wherein the first power circuit is arranged to transmit, to the source device, information on power supply capability of the relay device having been changed in response to other information on change of power supply capability of the sink device.

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